(Registration Ref: Letter No.MU/EXB/Ph.D./CR.141/Eco./2020-21/E.13, Dated 12-03-2021)

AGRICULTURAL TRANSFORMATION: A STUDY IN DAKSHINA KANNADA DISTRICT

Final Synopsis of the thesis submitted to Mangalore University for the award of the degree

Doctor of Philosophy

in

ECONOMICS

By

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September 2024

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INTRODUCTION

Agriculture is the largest sector of the Indian economy, in the sense that it is predominantly agricultural, with about two-thirds of the population depending directly on agriculture. The entire people's economic activities are bound to the state and health of this sector. Hence, agriculture is the backbone of the Indian economy and the central pillar of the country. It is also regarded as the mother of all industries and the maintainer of human life. Therefore, our country's economic prosperity depends largely upon agriculture's prosperity.

Agriculture is not just a sector of India's economy, but the very foundation of its livelihood, civilization, culture, and heritage. It is deeply rooted in our history and traditions, shaping our way of life and identity. With a population of about 1.39 billion, India is the world's second most populous country, Moreover, it is projected to become the most populous by 2027-30, leaving China behind. It is the seventh largest country geographically, with 328 M.ha area. India has about 160 M.ha of arable land, the second largest after the United States of America. It experiences all 15 prominent climates with 46 out of 60 soil types on the earth. About 50.0 percent of its total geographical area is cultivated, which ranks it among the top users of land for agriculture. In the more geographically suitable Indo-Gangetic Plain (IGP) and the deltas of the eastern coast, the proportion of cultivated to total geographical area often exceeds 90 percent. Indian agriculture, one of the world's oldest systems, is diverse, heterogeneous, unorganized, and often subjected to vagaries at various phases from 'seed to market.' It is the critical sector of the economy for the country's sustainable and inclusive economic growth. Agiculture sector engages 49.6 percent of the workforce, often seasonally, under-employed, and underpaid, accounting for about 17.0 percent of India's Gross Domestic Product (GDP).

Indian agriculture began as early as 11,000 BP with the domestication of animals and early cultivation of plants as evidenced in ancient literature. The Bhagavad Gita, Rig Veda, and Atharva Veda contain details on agriculture, like crops, cultivation, manuring, classification of herbs, and different varieties of plants. In ancient India, farmers started agricultural practices such as ploughing, sowing, reaping, and

harvesting on auspicious days as these were linked with religious customs. The Rig Veda proclaimed, ' *May the plough shares till our land properly; may the plough men go happily with the oxen.'* Maharshi Bhrugu, son of Maharshi Varun, observed, "*Food is the Brahma. Never speak ill about food. Never reject the food. Take an oath to produce plenty of food*". *Krishi Parashara*, with two hundred and forty-three verses, is the theory of agriculture expounded in a manner to benefit the farmers. Similarly, *Vrikshayurveda* discusses the science of plant life, such as procuring, preserving, and treating seeds before planting, selection of soil and nourishment, and plant protection from internal and external diseases.

Indian agriculture, a cornerstone of our civilization since its inception, has consistently made significant progress. However, there have been several periods in Indian history when food shortages, a grave concern, severely impacted civilization. In pre-Independent India, agriculture was heavily dependent on climate. Unfavorable monsoons, particularly the southwest monsoon, caused droughts and crop failure. Such droughts, sometimes in consecutive years, led to famines. Famines in India resulted in more than 30 million deaths over the 18th, 19th, and early 20th Centuries.

Agriculture is one of the oldest and most significant occupations of man. The development of agriculture is an essential factor for the economy of any country because it is a primary sector of the economy that provides the essential ingredients necessary for the existence of humankind. In India, agriculture is a primary source of economic activity. It contributes over one-third of the national income and employs about 70.0 percent of the rural population. India accounts for 7.68 percent of total global agricultural output. India is the second largest producer of agricultural products in the world, contributing to around 10.0 percent of the total value of India's commodity exports. Thirteen significant commodities, including tea, coffee, tobacco, cashews, spices, raw cotton, and sugar, are primary agricultural exports in India. Almost 30.0 percent of tea and 50.0 percent of coffee and jute produced in the country are exported. Indian agriculture has improved evidenced by the fact that percapita net availability of food grains increased to 491.2 grams (2016) from 395 grams in the 1950s.

Agricultural transformation and its development are multidimensional. It includes a variety of aspects like agricultural land utilization, intensity of cropping, crop

productivity, crop concentration, crop diversification, crop combination, commercialization of agriculture, nature of agrarian relationship, and maintenance of ecological balance and so on. Agriculture plays an essential role in the process of economic development of less developed countries like India. Agricultural development is an integral part of overall economic development. In India, agriculture is the primary source of national income and occupation. Agriculture and allied activities have contributed nearly 50.0 percent to India's national income, and the agricultural sector plays a strategic role in the country's economic development. It has already made a significant contribution to the economic prosperity of advanced countries, and its role in the economic development of less developed countries is vital. Indian economy is primarily based on agriculture, and it has been socio-economically far behind many countries in the developed world. Despite this, Indian agriculture has a reasonably successful history. It is now first in the world in producing milk, pulses, jute, and many fruits and second in rice, wheat, sugarcane, cotton, and a leading producer of spices, plantation crops, livestock, fish, and poultry.

Importance of Agriculture

Agriculture plays a crucial role in the life of an economy, and it is the backbone of our economic system. Agriculture provides food and raw materials for industry and employment opportunities to a substantial proportion of the population. In India, the main occupation of our working population is agriculture. About 48.9 percent of our population is directly engaged in agriculture. In 2011, about 263 million agricultural laborers considered agriculture a livelihood. Agriculture is the premier source of our national income. According to the National Income Committee and Central Statistical Organization, in 1970-71, the sector contributed 42.3, while in 2010-11, its contribution declined to 16.8 percent. The agriculture sector also provides fodder for livestock and poultry, which provide food in the form of milk, meat, and eggs, and they also provide draught power for farm operations.

Moreover, it meets people's food requirements. The agriculture sector neutralizes the country's negative balance of trade. Agricultural products like tea, sugar, rice, tobacco, cotton, spices, etc. constitute the main items of India's exports. They are significant for foreign exchange earnings and the country's economic development.

Agriculture has been the source of raw materials for the leading industries, such as cotton and jute textiles, sugar, tobacco, food processing, edible and non-edible oils,

etc. According to a U.N. Survey, industries with raw materials of agricultural origin account for 50.0 percent of the added value and 64.0 percent of all jobs in the industrial sector in India.

The development of the agricultural sector leads to a marketable surplus, and it is the primary support for railways and roadways, which transport the bulk of agricultural produce from farms to the mandis and factories. Agriculture is the primary source of revenue for both the central and the state governments of the country. The government is getting a substantial income from mandi taxes and value-added taxes on agro-based industries. The prospects of planning in India depend much on the agricultural sector. A good crop always provides impetus toward the planned economic development of a country by creating a better business climate for other sectors of the economy. A good crop also brings the government a good amount of finance to meet its planned expenditures.

According to Prof. Nurkse, disguised unemployment is a potential source of capital formation. Similarly, Prof. Lewis believed that the surplus labor force of the agriculture sector could be gainfully engaged in the industrial sector at a lower rate. Moreover, agriculture plays a significant role in the formation of human capital. India's unemployed people in agriculture can productively be engaged. It will help to generate capital in the country, and agriculture can stabilize the economy even during an economic depression; the agricultural sector continues to produce because it deals with necessities of life, and the producers already incur high fixed costs. Thus, it provides stability and even boosts the non-farm sectors in various ways. Therefore, agriculture occupies an essential place in the development of an economy. Any economic development program can only succeed if a robust agricultural base supports it. It receives top priority in a country like India, where most people are engaged in agriculture. Thus, its importance in the Indian economy arises from the fact that the country's economic prosperity largely depends upon the prosperity of agriculture. Therefore, the development of agriculture is an essential precondition for the development of the economy.

India is a country of about 1.33 billion people. About 58.7 percent of India's population live in rural areas, where they consider agriculture as their principal means of livelihood. In India, 75.0 percent or below the poverty line (BPL) population lives in rural areas and is directly or indirectly dependent on agriculture. Small farm holdings characterize Indian agriculture. The average farm size is only 1.57 hectares.

Around 93.0 percent of farmers have land holdings smaller than 4 ha and cultivate nearly 55.0 percent of the arable land. Agriculture contributes more than 15.87 (2018-19) to GDP, compared to 18.3 percent in 2013-14. In developed countries like the U.K. and USA, the share of agriculture in GDP is only 2. 0 percent.

Components of Agricultural Transformation

Agriculture is an essential segment of the traditional (feudal) economy; the transformation from feudalism to capitalism implies a transformation of agriculture. The experience of the evolution of the agricultural sector over Centuries tells us that the sector has evolved from being an essential food gathering (hunting and fishing) activity to an intensive production system due to population growth, increase in income, urbanization, technological revolution, and liberalization of international trade. The long-term development process also shows that the agricultural sector accounts for the country's economic output and a large share of the labor force. As countries develop, manufacturing and services sectors expand more rapidly; consequently, the shares of these sectors in overall GDP expand. The labor force also starts moving out of agriculture to these sectors. These changes lead to a fall in the agricultural sector's share of GDP and the share of the labor force employed in the agricultural sector. The other significant change along with this transformation is that the demand for agricultural products, both food and non-food, also changes. The food demand shifted from basic cereals to high-value products such as dairy products, fruits and vegetables, meat and meat products, and processed products due to income growth, urbanization, and trade liberalization. Moreover, as the consumption of high-value agricultural products rises, the output of the agriculture-food industry, which includes processing, wholesale, and retail, also expands.

The transformation of the Indian agricultural sector has been driven by several factors, in many instances similar to experience worldwide. These include supply-side factors such as policies to push growth, better and efficient use of resources like land and labor, introduction of new technology and increased use of modern inputs like chemical fertilizers and expansion of irrigation infrastructure; and investments in general infrastructure like roads, power as well as demand side factors such as population, income growth, urbanization, and demand from the rest of the world through gradual liberalization of international trade.

Land Use Pattern

In a broad sense, the term land use pattern refers to using land resources in different ecological settings. A country's land use pattern at any time is determined by its physical, economic, and institutional framework. In other words, the existing land use pattern in different regions in India has evolved because of the action and interaction of various factors, such as the physical characteristics of land, the institutional framework, and the structure of other resources (capital, labor, etc.) available. In addition, the region's geographical location relative to other aspects of economic development, such as transport, industry, trade, etc., influences the land use pattern. Scrutinizing the present land use patterns and trends in recent years will help us understand the Indian economic scenario.

Typology of Land Use

The total land in India can be divided into five categories from the perspective of land utilization. These are:

(i) Forests, (ii) Area not available for cultivation,

(iii) Uncultivated land excluding current fallow.

(iv)Fallow lands, (v) Cultivated Area.

The ***area not available for cultivation*** generally includes land put to industrial and other non-agricultural uses and barren and uncultivable land. *Uncultivated land* includes pasture, grazing land, tree cover, and wasteland. The *fallow lands* relate to land that is cultivable but is left unplanted. The *cultivated area* indicates the net sown area. The land utilization pattern for the year 1995 shows that the total area of India is 328.73 million hectares (m.ha). The data available for land use classification for the year 1995 was 304.83 m.ha, of which forest area represented 22.43 percent (i.e., 68.39 m.ha.). The largest share of the total geographical area was occupied by the net sown area (46.8 percent) with 142.82 m.ha.

On the other hand, the un-cultivated area comprising areas under non-agricultural uses and barren and uncultivable land represented 13.6 percent of the total area. Other uncultivated lands, excluding fallow land, which consists of - i) permanent pasture and other grazing land, ii) land under miscellaneous tree crops and groves not included in net sown area, and iii) wasteland, was stretched over 29.08 m.ha. (9.6 percent of the total geographical area). Of these, 11.24 m.ha. was under permanent pasture and other grazing land, 3.63 m.ha. It was under miscellaneous tree crops and

groves and 14.21 m.ha. under wasteland. Fallow land occupied an area of 23.3 m.ha, i.e., 7.6 percent.

Changes in Land Utilization Pattern

The observed land utilization patterns between 1950 and 2020 exhibit significant transformations. Notably, the forest cover expanded from 14.24 percent in 1950 to 22.43 percent in 1995, while the net sown area, indicative of cultivable land, increased from 41.77 percent to 46.85 percent during this period. This rise in cultivable land was facilitated by incorporating additional areas for agriculture. Moreover, the portion of land unavailable for cultivation decreased from 16.71 percent in 1950 to 13.54 percent in 1995, primarily due to the conversion of barren land into economically viable areas alongside a growth in non-agricultural usage. A notable decline was observed in uncultivated land, particularly in reducing miscellaneous tree crops and plantations from 6.97 percent to 1.19 percent. The gross cropped area substantially increased by 56.26 million hectares (from 131.89 m.ha. in 1950 to 188.15 m.ha. in 1995). This augmentation was accompanied by a rise in cropping intensity, elevating from 110.7 to 131.7, indicating amplified cultivation in both the Rabi and Kharif seasons. This transformation was facilitated by implementing significant irrigation projects, encompassing major, medium, and minor initiatives, resulting in expanded cultivation areas and higher cropping intensity.

Cropping Pattern

The cropping pattern indicates the proportion of area under different crops at a time. Cropping activities go on all year round in India, provided water is available for the crops. In India, the cropping pattern follows two distinct seasons: *the Kharif* season from July to October and *the Rabi* season from October to March. The crops grown between March and June are called *zaid*. The crops are grown solo or mixed (mixed cropping) or in a definite sequence (rotational cropping). The land may be occupied by one crop during one season (mono-cropping) or by two crops during one season (double-cropping), which may be grown in a year in a sequence.

Types of Cropping Systems

Different cropping systems are used in agriculture. The following cropping systems are in practice in each region of India, according to the climatic system.

a) **Mono-cropping:** Mono-cropping or monoculture may be due to climatological and socio-economic conditions or the specialization of a farmer in growing a particular agricultural resource crop. For example, under rain fed conditions, groundnut, cotton,

or sorghum are grown year after year due to the limitation of rainfall. In canal-irrigated areas, rice is grown under waterlogged conditions as it is impossible to grow any other crop.

b) **Multiple-cropping:** Growing two or more crops on the same land in one calendar year is known as multiple-cropping. It is the intensification of cropping in time and space dimensions, i.e., a more significant number of crops within a year and a greater number of crops on the same piece of land at any given period. It includes inter-cropping, mixed-cropping, and sequence cropping. Double cropping is where the land is occupied by two crops grown in a year in sequence.

c) **Inter-cropping:** Inter-cropping is growing two or more crops simultaneously on the same land with a definite row pattern—for example, growing *Setaria* and *red gram* in a 5:1 ratio. Thus, cropping intensity in the space dimension is achieved. Inter-cropping was practiced initially as insurance against crop failure under rain fed conditions. The main objective of inter-cropping is higher productivity per unit area and stability in production. The inter-cropping system utilizes resources efficiently, and their productivity is increased. For successful inter-cropping, there are specific essential requirements:

- The time of peak nutrient demands of component crops should be distinct.
- Competition for light should be minimal among the component crops.
- Complementarity should exist between the component crops.
- The differences in maturity of component crops should be at least 30 days.

d) **Mixed-cropping:** Mixed-cropping is the growing of two or more crops simultaneously intermingled without any row pattern. It is a common practice in most dry land tracts of India. Seeds of different crops are mixed in a particular proportion and sown. The objective is to meet the requirements of the family's cereals, pulses, and vegetables.

e) **Sequence-Cropping:** Sequence cropping is defined as growing two or more crops in a sequence on the same piece of land in a farming year. Depending on the number of crops grown in a year, it is called double, triple, or quadruple cropping, involving two, three, and four crops, respectively. In addition, relay and ratoon cropping also exists. Relay cropping refers to planting the succeeding crop before harvesting the preceding crops. Ratoon cropping or ratooning refers to raising a crop with re-growth from roots or stalks after crop harvest.

f) **Integrated Farming System:** An integrated farming system is a holistic method of combining several enterprises, like cropping systems, dairying, piggery, poultry, fishery, beekeeping, etc., harmoniously to complement each other. The objective is efficient resource utilization and maximization of profit in such a way as to cause the most minor damage to soil and the environment. The farmers' climatic factors and resources determine the cropping pattern on a farm. Though climate plays the most vital part in crop selection, the area under crop is also influenced by farmers' economic considerations, namely irrigation water, cost of inputs, and prices of the products.

Irrigation in India

In any locality, the prevalent cropping system is the cumulative result of past and present decisions by individuals, communities, governments, or agencies. Water availability, either through precipitation or irrigation, is a primary requisite for higher cropping intensity. It is increasingly becoming realized that land and water resources are not unlimited and that their wise use is imperative. This is especially so for countries like India, where the population pressure continuously increases. Tropical countries like India are fortunate in that the temperature conditions remain favorable practically throughout the year for growing crops. However, it is crucially dependent upon water supply through natural precipitation or irrigation.

All the components of Indian agriculture discussed above, are transforming. Few transformation may be seen in short-run and few others are in long run. Some of the transformation are desirable and few others cause imbalances in the agriculture sector. For example, in case of land use pattern, if land under cultivation is increasing it’s a good sign. Whereas, with regard to cropping pattern commercial crops replacing food crops is not a good sign. Because, ever-growing population in India may demand more food for their sustenance. Therefore, there must be a balance between food crop and commercial crop cultivation.

However, there is a need to check the transformation in agriculture sector to retain the food supply and raw material supply to growing industrial sector. Moreover transformation in agricultural sector has environmental implications. Therefore, diagnosing the pros and cons of agricultural transformation assumes importance.

IDENTIFIED RESEARCH GAP

A literature review is a comprehensive overview of all the knowledge on a specific topic. In other words, a literature review is a scholarly paper that includes current knowledge, substantive findings, and theoretical and methodological contributions to a particular topic. When one decides on a research topic, the first step in conducting research is to learn more about the previous research published on the topic, which eventually translates into a literature review when one writes a research paper. The literature review is one of the pillars of the research idea since it provides context, relevance, and background to the research problem. Literature reviews are secondary sources and do not report new or original experimental work.

The study's literature review on agricultural transformation in India is broadly categorized into studies on structural transformation, functional transformation, environmental issues, and other issues. It involves land use patterns, cropping patterns, farm management, farm size, land holdings, agricultural labor, resource management, climate change, agricultural marketing, water management, technological changes, agricultural credits, research, invention and innovation, economic and environmental issues, etc.

- Studies on structural transformation,
- Studies on functional transformation
- Studies on environmental issues and studies on other issues

After reviewing the literature on Indian agriculture transformation, we understood that there is a need to research on the nature of transformations, the reasons for transformations and to identify undesired transformations both for economical and environmental perspective. In this regard, the research studies on agricultural transformations we identify the following research questions.

- What is the nature of agriculture transformation?
- What are the reasons for and consequences of structural transformation in agriculture?
- What are the reasons for and consequences of functional transformation in agriculture?
- What is the impact of such a transformation on the economy and environment?

Considering these research questions, an attempt is made in this study to investigate the nature and consequences of agricultural transformation in Dakshina Kannada, Karnataka.

STATEMENT OF RESEARCH PROBLEM

The transformation of the agriculture sector is natural, and the factors influencing each sectors are unique means differ from each other. Agricultural transformation has taken place in different dimensions for different reasons. The reasons could be changes in the land use pattern, natural conditions like climate, rainfall, technological change, infrastructure development, etc. Moreover, transformation in other related sectors also influence transformation in agriculture. Nevertheless, in the Indian case of agricultural transformation, the influence of market-related issues is more significant. The transformations from food crops to commercial crops are economically valid, but on the other hand, from the food supply point of view, it is perilous; therefore, there is a need to study the nature and extent of agricultural transformation and their consequences from the sustainable agriculture point of view.

OBJECTIVES OF THE RESEARCH

The primary purpose of this study is to analyze the transformations in the agriculture sector and to diagnose the impact of such transformations in a micro-region. The specific objectives of the study are.

1. To examine the nature of agricultural transformation in India in the last 50 years
2. To analyse the nature of agricultural transformation in Karnataka and Dakshina Kannada district
3. To analyze the nature and factors responsible for the structural transformation of agriculture in D.K district
4. To analyze the nature of functional transformations in agriculture and adoption of modern technology in D,K District
5. To diagnose the impact of such transformations on environment and agricultural productivity in D. K district
6. To design a model of sustainable agriculture in a micro region

HYPOTHESES

H_1: Agriculture transformations have improved the farm income.

H_2: Adoption of science and technology in agriculture resulted in a labour scarcity.

H_3: Agricultural transformation has a strong environmental impact.

METHODOLOGY

The methodology of the study corresponds to its objectives concerning agricultural transformation through structural and functional changes. The structural transformation looks at changes in land distribution, landholding pattern, and overall organization of agricultural holdings in respect of structure, land distribution, concentration, ownership, size and distribution of landholdings, and land-use pattern from traditional to more modern ones. Functional transformation focuses more on the use of changes in agricultural methods and technologies, including the use of HYVs of seeds, changes in the production structure, and inventions in farming techniques to make farming more productive and efficient. This study has used a historical perspective in order to track the changes in these transformations over time, identifying key variables and determinants of change in agriculture as it takes shape in the region under survey.

Variables of analysis

The analysis considered variables related to issues such as land use pattern, cropping pattern, farm management, farm size, land holdings, agricultural labour, resource management, climate change, agricultural marketing, water management, technological changes, agricultural credits, research, invention and innovation, economic and environmental issues, etc.

Study Area

The study will be undertaken in Dakshina Kannada district of Coastal Karnataka. Elders have observed that over the last 50 years, the agriculture sector has undergone many changes. Natural factors, functional and structural factors, and other factors have changed agricultural productivity and the sector. Given this, only Dakshina Kannada district is examined for the study of agricultural transformation.

Sources of Data

Data is one of any research study's most essential aspects. Researchers in different fields of study can use different methodologies, but every research is based on data, which is analyzed and interpreted to obtain information. There are two types of data sources: primary and secondary. This study involves both primary and secondary data sources. The primary data sources were collected from farmers in the District of Dakshina Kannada. The secondary data has been collected from different sources,

including published and non-published, as well as government and non-government records.

Sampling

Sampling in research aims to find representative samples to avoid bias. It is often impractical and sometimes undesirable to try and study the entire population. In this study, experience is considered when selecting samples. **Stratified** and **purposive random sampling** methods were used to collect the appropriate sample data. The study is historical, so farmers' experience is very much required to arrive at the study's objectives. However, 60 samples from each taluk, totaling 300 farmers, were interviewed for the study as it was considered necessary for the required analysis.

Tools of Analysis

The transformation of agriculture in the district is analyzed in terms of changes in land utilization pattern, cropping pattern, net area sown, irrigated land, traditional practices to modern practices, and so on over a long period. Hence, both primary and secondary were analyzed using statistical tools like **ratios, growth rates, and time series analysis**. Time Series analysis is carried out using district level data obtained from the District Statistical Office. Results were presented in the graph.

Further, reasons for the agricultural transformation in the district are analyzed based on the experience and opinions of the sample farmers using the Likert's Scale.

Growth rates of land use pattern, cropping pattern, production and yield of major crops are worked out for five decades. Using **Semi Average** Method for every **decade** time series analysis on change in land use, cropping pattern, production, and yield of major crops were carried out. In addition to the analysis of the data, here opinions of the senior farmers are also analyzed to understand the transformations in agriculture.

Farmers opinions Survey with regards to agricultural transformations is conducted and data analzed using Likert's Scales**.** Likert (1932) proposed a summated scale for assessing survey respondent's attitudes. Individual items in Likert's sample scale had five response alternatives: Strongly Approve, Approve, and Undecided, Disapprove, and Strongly Disapprove. Likert noted that descriptors could be anything -- it was not necessary to have negative and positive responses. He implied that the number of alternatives was also open to manipulation. Indeed, we see contemporary work using many classifications besides the traditional five-point classifications; some researchers use an even number of categories, deleting the neutral response. Likert

scaling presumes the existence of an underlying (or latent or natural) continuous variable whose value characterizes the respondents' attitudes and opinions. If it were possible to measure the latent variable directly, the measurement scale would be, at best, an interval scale.

A **Likert scale** is a psychometric scale commonly involved in research that employs questionnaires. It is the most widely used approach to scaling responses in survey research, such that the term is often used interchangeably with rating scale or, more accurately, the **Likert-type scale**, even though the two are not synonymous. The scale is named after its inventor, Psychologist Renisis. (LIKERTS, RENISIS 1932). Likert distinguished between a scale proper, which emerges from collective responses to a set of items (usually eight or more), and the format in which responses are scored along a range. The scale range captures the intensity of their feelings for a given item. In contrast, the analysis of multiple items (if the items are developed appropriately) reveals a pattern that has scaled properties of the Likert identified.

Respondents' needs, expectations, and opinions regarding their satisfaction with the sample laborers on various parameters were collected in four-level scores ('*Very much,' 'much,' 'somewhat,' and 'not all'*). The corresponding scores were multiplied by the number of respondents, and the average scores of each parameter were computed separately for rural and urban cases using the following formula.

$$\frac{x_1s_1+x_2s_2+x_3s_3+x_4s_4}{X}$$

Such average scores of various parameters were obtained and used to compute the results.

SCOPE AND LIMITATIONS

Agricultural transformations can rapidly reduce poverty by creating powerful rural economic growth engines. The study on the transformation of agriculture will give us:

- The knowledge about the nature of agricultural transformation in India
- The reasons and factors responsible for the transformation of the agriculture sector
- The impacts of agricultural transformation on the environment and the productivity of the agriculture sector.

In this study an attempt is made to analyze the structural and functional transformation in Dakshina Kannada district. The analysis is carried out using

secondary data and primary data obtained by the personal interview of senior experienced farmers. Since the study is confined to Dakshina Kannada district. Its results may not be similar in other districts. Because, the agricultural activities are highly regional in nature.

CHAPTER'S SCHEME

The research study " **Agricultural Transformation: A Study in Dakshina Kannada District"** is organized into Seven Chapters, as detailed below.

CHAPTER – I	:	**"INTRODUCTION"** presents an overview of the research study's subject matter by clearly detailing the conceptual framework, need for the present study, research questions, objectives, and hypotheses. In addition, this chapter will provide information on methods—sources and methods used for data collection, tools of analysis, scope and limitations of the present study, and chapter scheme.
CHAPTER – II	:	**"THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE"** outlines the theoretical foundation of agricultural transformation at the macro and micro levels and provides a detailed review of earlier research studies conducted in this field.
CHAPTER– III	:	**"AGRICULTURAL TRANSFORMATION: INDIAN EXPERIENCE"** critically discusses agricultural transformation in India and analyzes the growth of the agricultural sector in India.
CHAPTER – IV	:	**"PROFILE OF THE STUDY AREA AND SAMPLE"** provides a physical, demographic, and socio-economic profile of the study area and a sample description.
CHAPTER – V	:	**"STRUCTURAL TRANSFORMATION"** Provides an empirical analysis of structural transformation of agriculture and the causes of such transformation in the coastal Karnataka (Research Results)
CHAPTER – VI	:	**"FUNCTIONAL TRANSFORMATION"** Analysis of the functional transformation and its impact on agriculture in a micro-region (research results)
CHAPTER- VII	:	**"SUMMARY AND CONCLUSION"** presents a summary of the research results and discussions from the preceding chapters, highlighting the significant economic implications of both structural and functional transformations in agriculture within a micro-region. It explores how these changes impact the local economy, livelihoods, and agricultural sustainability. The chapter concludes by offering directions for future research in this field, emphasizing the need for further investigation into the dynamics of agricultural transformation and its broader economic effects.

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MAJOR FINDINGS

- India’s economic security continues to be predicated upon the agriculture sector, and the situation is not likely to change in the foreseeable future. Even now, agriculture supports 58.0 percent of the population, as against about 75.0 percent at the time of independence. In the same period, the contribution of agriculture and allied sector to the Gross Domestic Product (GDP) has fallen from 61 to 18.03 percent.
- India supports 16.8 percent of the world’s population, 4.2 percent of the world’s water resources, and 2.3 percent of global land. Moreover, per capita, the availability of resources is about 4 to 6 times less than the world average.
- Around 51.0 percent of India’s geographical area is already under cultivation compared to 11.0 percent of the world average. The cropping intensity of 136 percent has registered an increase of only 25.0 percent since independence.
- Rain-fed dry lands constitute 65.0 percent of the total net sown area. There is also unprecedented land degradation (107 million ha) and groundwater resources and a fall in total factor productivity growth rate. This deceleration needs to be arrested, and agricultural productivity must be doubled to meet the population's growing demands by 2050.
- The country recorded impressive agricultural achievements during three decades since the onset of the green revolution in the late sixties. It enabled the country to overcome widespread hunger and starvation, achieve self-sufficiency in food, reduce poverty, and bring economic transformation to millions of rural families.
- Natural resource base of agriculture, which provides for sustainable production, is shrinking and degrading and adversely affecting the ecosystem's production capacity.
- Almost 37.0 percent of the land on the Earth is used for agriculture. In India, almost 60 percent of the total land area is used for agriculture. In Brazil, almost 34.0 percent of land is used for agriculture, one of the major occupations.
- Agriculture, with its allied sectors, is India's largest source of livelihood. 70.0 percent of its rural households still depend primarily on agriculture for their livelihood, with 82.0 percent being small and marginal farmers. . In 2021-22, total food grain production was estimated at 315.7 million tonnes (MT).
- India is the largest producer (25% of global production), consumer (27% of world consumption), and importer (14%) of pulses in the world.

- India's annual milk production was 209.96 MT (2020-21), making India the largest producer of milk, jute, and pulses, with the world's second-largest cattle population of 190 million in 2012. It is the second-largest producer of rice, wheat, sugarcane, cotton, and groundnuts and the second-largest fruit and vegetable producer, accounting for 10.9 percent and 8.6 percent of the world's fruit and vegetable production, respectively.
- Area under Agriculture emerges as the dominant category with an increase in its share from about 42.0 percent in 1950-51 to 47.5 percent in 1993-94.
- Agricultural land (% of land area) in India was reported at 60.22 percent in 2020
- The next major land use category for India is Forests which accounted for 22. 0 percent in 1993-94 and was 8.0 percent higher compared to 1950-51.
- As per the India State of Forest Report-2021, forest and tree cover in the country has increased by 2,261 square kilometers since the last assessment in 2019. India's total forest and tree cover was 80.9 million hectares, which accounted for 24.62% of the country's geographical area.
- The cropping patterns are affected by changes in agrarian policy, availability of agricultural inputs, and technological improvement. Thus, the cropping patterns are beneficial in improving soil fertility, thereby increasing the yield of the crops.
- Technology was the driver of the Green Revolution, as about 80.0 percent of the production gains were attributed to yield enhancements.
- The intensified efforts in oil seed crop research post-Technology Mission on Oil Seeds (TMO) in 1986 resulted in Yellow Revolution with a quantum jump in edible oil production from 10.8 Mt (1985-86) to 24.7 Mt (1998-99). From 1985 to 1996, area under oil seed cultivation increased from 19.0 to 26.0Mt and in 2020-21 increased to 36.1 Mt.
- To achieve a similar boost in pulses production, they were brought under TMO in 1991. The continued efforts for about three decades in pulses brought about the ‘Pulse Revolution’ by providing near self-sufficiency in pulses in the late 2010s (Yadav et al., 2019). The production of pulses, which remained almost constant at 14-15 Mt till 2014-15, jumped to 25.72 Mt (2020-21).
- India also witnessed Sugar Revolution, with sugarcane production increasing from 57.05 Mt (1950-51) to 405.42 Mt (2019-20).
- In independent India, 115 improved varieties have been developed, which helped increase sugarcane production with improved sugar recovery.

- ICAR has released over 6000 varieties for cereals, oil seeds, pulses, fiber crops, forage crops, sugar crops, etc. This list includes 55 varieties developed through marker-assisted selection to fulfill the various requirement of the farmers.
- In recent years (2014-21), 1575 high yielding varieties of field crops were released, more than 1300 varieties of which are climate resilient.
- The state-wise pattern of diversity based on 30 crops reveals that most of the states in the northern region fall under the category of states producing less number of crops and hence are less diverse, whereas almost all the eastern and southern states are highly diverse as they produce relatively more number of crops
- Interestingly, when we measure the level of spread across states in India, both the northern and eastern regions show higher levels of concentration
- Five distinct phases of growth were identified: (i) Phase I: Pre-green revolution Period (1950-51 to 1967-68) (ii) Phase II: Early green revolution period (1968-69 to 1985-86) (iii) Phase III: Period of wider dissemination (1986-87 to 1996-97) (iv) Phase IV: Post-Reform Period (1997-98 to 2005-06) (v) Phase V: Period of Recovery (2006-07 to 2009-10/2010-11)
- The pre-green revolution period (1950-51 to 1967-68) was characterized by a steep decline in growth in GDP agriculture, with decadal growth rates found to plummet sharply from 2.78 percent to 1.06 percent between 1950-51 and 1967-68.
- The green revolution was kick-started in 1966, and the effects of adopting superior technology and institutional reforms were found to manifest from 1968-69 onwards. The subsequent period is classified as the early green revolution period, and a visible reversal of growth in GDP agriculture was observed. The decadal growth rate reached nearly 3.0 percent by the decade ending with 1985-86.
- The broader dissemination of technology was characterized by sustained growth in the sector for over a decade, peaking in 1996-97. The deceleration of growth started from 1997-98 onwards, and a clear indication of the agricultural sector slumping was visible till 2005-06. This slump is widely perceived as an outcome of the substantial diversion of resources away from agriculture to other sectors of the economy.
- However, a significant recovery was observed in the last few years, pushing the decadal growth rates above 3.0 percent. In a nutshell, the growth series reflects a sharp deceleration of the agricultural sector in the post-reforms period and an unambiguous turnaround in the last five years, which also happens to be the 11th five-year plan period.

Karnataka Scenario

In Karnataka, agriculture is the primary occupation for most of the rural population. As per the Population Census 2011, agriculture supports 13.74 million workers, of which 23.61 percent are cultivators and 25.67 percent are agricultural workers. A total of 123,100 km² of land is cultivated in Karnataka, constituting 64.6 percent of the state's total geographical area. Vast steppes of drought-prone regions and sporadic patches of irrigated areas characterize the agricultural sector of Karnataka. Thus, a large portion of the state's agricultural land is exposed to monsoon vagaries with severe agro-climatic and resource constraints. Agriculture employs more than 60 percent of Karnataka's workforce.

It is also the largest producer of spices, aromatic and medicinal crops, and tropical fruits. It is the second-largest milk-producing state after Gujarat. Karnataka is also the country's second-largest producer of grapes and accounts for the two productions of 12 percent of total fruits, 8 percent of total vegetables, and 70 percent of coffee. It is the third-largest producer of sugar and ranks fourth in sugarcane production. In floriculture, Karnataka occupies the second position in India. Karnataka is the primary silk-producing state in the country.

- Areas under permanent pasture decreased consistently, and areas under non-agricultural use increased sharply during the past four decades. Fallow land, six around 11 lakh ha, increased to 13.50 lakh ha after the mid-nineties.
- Fallow land area fluctuates from year to year; in specific years (like 1998-99, 1990-2000, 2001-02, 2006-07, and 2008-09), the percentage reached above 10 percent of the total (190.50 lakh ha) geographical area of the state.
- The net sown area also started shrinking after the 1990s. The net sown area, which accounted for 55.776 percent of the total geographical area of the state in the triennium ending 1988, declined to 54.28 percent during the triennium 2007-09
- The overall trends in the area allotted for various crops during five decades show that the cropping pattern in Karnataka is dominated by food crops, with a share of more than 60.0 percent of the gross cropped area in the state. Rice, sorghum, and finger millet were the major cereals till 2000-03.
- However, the share of maize crops went up substantially after 2005 due to improved productivity and prices. The area under food crops declined from 79.1 percent in the 1960-63 triennium to 59.4 percent of the GCA in 1990-93.

- The area under cereals declined from 60 percent in 1960-63 to 43 percent of the GCA in 2007-08 (Table- 9 and Fig 3).
- Acreages of millet crops like sorghum and pear millet and minor millets declined consistently. The reduction in the share of cereals was due to shrinkage in the area devoted to millet.
- Area under pulses, which stood at 11.0 percent during the early seventies, increased to 18.3 percent in 2007-10.
- Oil seeds grew their share from around 10 to 11 percent during the sixties and seventies to more than 20.0 percent in the early 1990s, and it was 17.0 percent of the GCA in 2007-10. The Technology Mission on Oil Seeds introduced in the mid-eighties conditioned the expansion of area under oil seeds.
- Cotton occupied 9 percent of the GCA in the early 1980s but came down gradually to little more than 3.0 percent of the GCA in 2007-10.
- Area under chickpea hovered around 1.5 percent of the GCA between the 1970s and 1990s but rose to 6.1 percent in 2007-10. Similarly, the area under pigeon peas increased from 2.5 percent in 1970-73 to 5 percent in 2007-10.
- The area under other crops, which include fruits, vegetables, and plantation crops, increased gradually from 11.4 percent of GCA in the early seventies to 15.8 percent in 2007-10.
- Total Pulses production underwent varying trends over the years, demonstrating a significant surge from the 1990s onwards, as evidenced by the figures of 241,000 metric tonnes in 1950 and a remarkable 914,000 metric tonnes in 2021.
- The production of cereals exhibited a consistent pattern of growth, which mirrors the progress made in agricultural techniques. This is evident from the data points of 4,620,000 metric tonnes in 1950, escalating to a substantial 18,805,000 metric tonnes by the year 2021.
- Since the 1990s, there has been significant expansion in the production of horticulture crops, underscoring a shift towards diversification and heightened emphasis on cultivating high-value crops. This transformation is evident in the data, with horticulture crop production rising from 5,909,000 metric tonnes in 1990 to a noteworthy 16,213,000 metric tonnes in 2021.
- The production of other principal crops has undergone a substantial increase from the 1990s to 2021, signifying a dynamic evolution in the agricultural scenario. This growth is evident in the data, with key crops such as oil seeds, sugarcane, and cotton

contributing to the rise. In 1990, these crops collectively yielded 11,201,000 metric tonnes, while the combined production surged to an impressive 19,394,000 metric tonnes by the year 2021.

Empirical findings

The total geographical area of the Dakshina Kannada district is 4.77 lakh hectors; out of this, about 26.91 percent area is forest, land not available for agriculture (non-agricultural land & non-cultivable land), and non-cultivated area. Beside this about 12.90 percent area are fallow land.

- Marginal Agricultural Land Holders (less than 1 hectare) are 74.18 percent of the total landholders in the D.K district
- Small landholders (1-2 hectares) are 17.58 percent of the total landholders in the D.K district
- Semi Medium landholders (2-4 hectares) are 6.36 percent of the total landholders in D.K district
- Medium landholders (4-10 hectares) are) 1.70 percent of the total landholders in the D.K district
- Large l landholders (above 10 hectares) are 0.18 percent of the total landholders in the D.K district
- Total land holdings have increased from 1,35,199 to 1,72,607 during the years 1995-96 to 2000-01. During the same time period, the marginal land holdings number has increased from 89,299 to 1,19,330, and in the small holdings category, there is an increase of 5,662 numbers.
- Agricultural transformation in Dakshina Kannada district is seen in land utilization, cropping pattern, and farm practices.
- Total geographical area of the district has declined almost 50.0 percent after the division into the Udupi district in the late nighties.
- Proportion of the forest area to the total geographical area remained almost the same, around 26-27 percent.
- Proportion of land unavailable for cultivation to geographical area has increased to about 24.0 percent from 19.0 percent from 1989-90 to 2021-22.
- Uncultivated Lands like cultivable waste, permanent pasture, and tree crops have decreased remarkably as their proportion to total geographical area declined from 18.0 percent to 9.0 percent.

- Fallow land in the district has declined remarkably, and the ratio of net area sown to total geographical area has slightly increased from 30.0 percent to 39.0 percent from 1990-91 to 2021-22.
- Area under crops grown more than once has declined over the years. Further, the cultivation of pulses and vegetables has almost stopped in practice.
- Number of small farmers and the area covered by their farm size has increased over the years indicating farm divisions are taking place continuously.
- Area under paddy declined remarkably in the last 40 years. However, the area under plantation crops increased impressively. Coconut, Arecanut, Cashew, and Rubber are the important plantation crops grown in the district.
- Banana and pepper are other plantations, showing increased land under cultivation
- Majority (70.3%) of the sample farmers belong to the age group of 40 and above. Most of the sample farmers are less educated in the sense that about 86.0 percent of them are educated at the pre-university level or less than the pre-university level.
- The sample farmers along with agriculture engaged with allied activities like animal enterprises, small-scale manufacturing, and small business. We understand that a large proportion (47%) of the sample farmers are engaged in dairy, Poultry, and fishing activities.
- Average cultivable lands which are not cultivated for various reasons among the big, marginal, and small farmers are 0.61 acres, 0.5 acres, and 0.41 acres, respectively. The average cultivable and presently not cultivated land is 1.52 acres for the total sample farmers.
- About 95.0 percent of the small sample farmers cultivated Paddy before 15 years. Among the sample small farmers, 32.0 percent of them were not cultivating areca nut are turned out to cultivate areca.
- Among the sample farmers, the majority (61.0 percent) have been cultivating Paddy for 15 years or more. Additionally, 1about 35.0 percent of sample farmers are involved in cultivating other crops, specifically horticultural crops.
- Furthermore, about 33.0 percent of sample farmers have been engaged in Arecanut cultivation for 15 years and above, while around 31.0 percent are focused on coconut cultivation
- Large proportion of sample farmers keep diversifying their crops for various reasons.
- Huge requirement of Initial investment is the main reason for crop diversification, which scored 3.67, and demand for the product (3.65), increase in income (3.61), and

problems related to marketing (3.59) are the other main reasons for crop diversification in the study area**.**

- Production of paddy declined. Production of all the plantation crops has increased in the last 40 years.
- Yield of paddy, areca nut, cashew nut, and coconut has increased in the last thirty years. Whereas, the yield of pepper has declined. pepper is grown as a mixed crop on the plantation farms
- The crop Arecanut gives more returns (Rs.139600) compared to Paddy (Rs.8484), Coconut (Rs.8400), Rubber (Rs.3100), and other crops (Rs.2600).
- HYV seeds represent a significant leap in agricultural technology, designed to address the pressing issues of food security and sustainable farming in Dakshina Kannada district.
- Improved varieties of paddy seeds like IR-64, BPT-5204, Jaya, and Sona Masuri are popular choices among farmers in Dakshina Kannada.
- The major HYV seed variety used for arecanut cultivation in the district is VTL (Vittal Tall), which is renowned for its higher nut yield and resistance to pests and diseases.
- For rubber cultivation, popular HYV clones like RRIM 600 and RRIM 703 are widely preferred by farmers in Dakshina Kannada. These clones are known for their superior latex yield and resistance to diseases like South American Leaf Blight (SALB).
- In the case of black pepper, HYV varieties such as Panniyur-1 and Panniyur-2 have gained popularity in the district.
- For cashew cultivation, farmers in Dakshina Kannada often use HYV varieties like VRI-2 (Vengurla-2) and Bhaskara.
- Varieties like Chowghat Orange Dwarf and Chowghat Green Dwarf are examples of HYV coconut varieties being adopted in certain areas.
- The widespread adoption of HYV seeds in Dakshina Kannada has been instrumental in driving rural development. Increased farm income has uplifted the living standards of farmers, leading to better access to education, healthcare, and improved infrastructure.
- Farmers in the district commonly use chemical fertilizers like urea, di-ammonium phosphate (DAP), and potassium chloride (MOP). These fertilizers provide nitrogen, phosphorus, and potassium, respectively, which are crucial for the proper development of the rice plant, Areca nut, rubber, and other principal crops.

- Chemical fertilizers usage gradually increased in the district, from 1990-91 to 2020-21. Nitrogen 4123(‘00Tonnes), Phosphorous 2561(‘00Tonnes), Potash 1645(‘00Tonnes) in total 8329(‘00Tonnes) in 1990-91, which increased to Nitrogen 9761 (‘00Tonnes), Phosphorous 5625 (‘00Tonnes), Potash 8111 (‘00Tonnes) in total 23497 (‘00Tonnes) in 2020-21.
- Farmers in Dakshina Kannada resort to pesticides to protect the rice crop from threats like leaf folders, stem borers, and blast disease. Commonly used pesticides in paddy fields include insecticides like chlorpyrifos and imidacloprid and fungicides like carbendazim and tricyclazole
- Arecanut trees are susceptible to pests such as mites, scale insects, and leaf-eating caterpillars. To combat these threats, farmers apply pesticides like dimethoate, quinalphos, and monocrotophos.
- Pests like rubber scale insects, mites, and white grubs can significantly impact latex production. To counter these pests, farmers use pesticides like chlorpyrifos, fipronil, and carbosulfan, which help in preserving rubber tree health.
- Pepper, a sought-after spice, faces threats from pests such as thrips, mites, and whiteflies, which can damage the pepper vines and affect yield. Pesticides like imidacloprid, fenazaquin, and profenofos are commonly used to protect pepper crops from these harmful insects.
- Pests like rhinoceros beetles and red palm weevils pose significant threats to coconut trees. Pesticides such as chlorpyrifos, imidacloprid, and fipronil are used to protect coconut palms and maintain the health of the groves.
- Farmers in Dakshina Kannada employ centrifugal pumpsets, both electric and diesel-powered, to draw water from nearby water bodies or wells.
- The region employs two primary irrigation patterns for paddy fields: flood irrigation and systematic irrigation. Flood irrigation involves flooding the fields with water, which is often diverted from nearby rivers or water bodies practiced in low-lying areas with abundant water sources. On the other hand, systematic irrigation, such as drip and sprinkler irrigation, is gaining popularity.
- Arecanut cultivation predominantly relies on rain-fed irrigation, during prolonged dry spells, farmers may resort to supplemental irrigation using pumpsets or sprinklers to ensure adequate water supply for the trees.

- Rubber cultivation in Dakshina Kannada benefits from a well-regulated irrigation pattern, the combination of natural rainfall and supplemental irrigation ensures optimal latex yield and maintains the overall health of rubber plantations.
- The total irrigated area increased to 159026 hectares in 2020-21 from the previous 72,399 hectares in 2011-12. Among the sources, open wells covered 46992 hectares, tube wells covered 93069 hectares, lift irrigation accounted for 151 hectares, and other sources encompassed 19979 hectares. This indicates a growth in overall irrigation, particularly noticeable in open wells, tube wells, and other sources over this period.
- The total agriculture marketing increased to 15 in 2020-21 from the previous number 8 in 2000-01. Among the sources, regulated markets covered 5 and submarkets are 8 in number. This indicate a gradual growth in the overall agriculture marketing.
- Sample farmers noticed that environmental issues are more in the Dakshina Kannada District.
- The primary reasons for environmental issues are attributed to irregular rainfall, scoring 3.75, followed by an increase in plant diseases at 3.63, climate change at 3.58, and an elevated occurrence of droughts at 3.57. Additional contributing factors include the use of chemical fertilizers at 3.27, a decrease in the quality of produce (scored at 2.79), greater environmental impact due to diversified crop cultivation (scored at 2.76), and a decrease in soil fertility (scored at 2.57).

Empirical findings based on learning objectives.

Objective 1. To examine the nature of agricultural transformation in India in the last 50 years:

- The adoption of High-Yielding Varieties (HYV) of seeds has revolutionized agricultural productivity across India.
- Land reforms and Green Revolution technologies led to increased food grain production, particularly in states like Punjab and Haryana.
- Mechanization and modern irrigation methods reduced the dependency on monsoons.
- The shift from subsistence to commercial agriculture, focusing on cash crops like sugarcane and cotton, transformed the rural economy.
- Labor scarcity due to rural-urban migration and a decrease in farming families increased mechanization across India.

Objective 2. To analyze the nature of agricultural transformation in Karnataka and Dakshina Kannada district:

- The total geographical area of Dakshina Kannada decreased by almost 50.0 percent after the creation of Udupi district in the late 1990s.
- Proportion of non-cultivated land and land unavailable for cultivation increased to 24.0 percent in 2021-22, up from 19.0 percent in 1989-90.
- Increased plantation crop cultivation (Coconut, Arecanut, Rubber) and a remarkable decline in paddy cultivation.
- HYV seeds such as IR-64 and Vittal Tall (for Arecanut) are widely used, contributing to higher yields.
- Labor scarcity has pushed small farmers to diversify into horticulture and agro-allied activities, including dairy and poultry.

Objective 3. To analyze the nature and factors responsible for the structural transformation of agriculture in Dakshina Kannada district:

- Marginal landholders (less than 1 hectare) comprise 74.18% of total landholders, indicating a trend of fragmented land holdings.
- The area under crops grown more than once has decreased over the years, pointing to crop diversification and reduced land availability for food grains like paddy.
- The district has seen a structural shift from paddy cultivation to higher-value plantation crops such as coconut and areca nut.
- Labor scarcity and the shift from traditional farming to horticulture have led to higher mechanization in irrigation practices like drip and sprinkler systems.

Objective 4. To analyze the nature of functional transformations in agriculture and the adoption of modern technology in Dakshina Kannada district:

- The increased adoption of HYV seeds for plantation crops like areca nut (VTL) and rubber (RRIM 600) boosted productivity.
- Mechanization in irrigation and the use of centrifugal pump sets (electric and diesel-powered) helped cope with irregular rainfall patterns.
- Chemical fertilizer usage increased drastically, with a significant rise in the application of nitrogen, phosphorous, and potash.
- Labor shortages have led to increased mechanization in paddy fields and higher reliance on supplemental irrigation, with laborers turning to non-agricultural occupations.

Objective 5. To diagnose the impact of such transformations on the environment and agricultural productivity in Dakshina Kannada district:

- Environmental degradation due to irregular rainfall, droughts, and climate change are primary concerns, scoring 3.75 and 3.57, respectively, among sample farmers.
- The use of chemical fertilizers has increased environmental stress and led to a decrease in soil fertility, contributing to an overall decline in the quality of produce.
- Diversified cropping and monoculture of plantation crops like arecanut and coconut have led to increased plant diseases and pest attacks, demanding higher pesticide usage.
- Labor scarcity contributes to the use of more chemicals for pest and weed control, which exacerbates environmental problems and further reduces agricultural sustainability.

Objective 6. To design a model of sustainable agriculture in a micro-region:

- A sustainable agricultural model for Dakshina Kannada needs focus on reducing chemical fertilizer usage and promoting organic practices to restore soil health and improve crop resilience.
- Adoption of agroforestry techniques, integrating crops like pepper and banana with plantation crops, could enhance biodiversity and increase income streams for farmers.
- Implementing cooperative farming models for small and marginal farmers could help optimize land use, reduce input costs, and alleviate labor shortages.
- Labor scarcity solutions could include government support for mechanization, workforce training programs in sustainable farming practices, and incentivizing youth to engage in agriculture.

IMPLICATIONS OF THE RESEARCH

Analyzing the transformation of agriculture in different dimensions would shed light on land use patterns, cropping patterns, environmental issues, and the availability of food grains for humankind and raw materials for growing industrialization. Further, it will help us understand the rural economy in backward, agrarian economies like India. Diagnosing the causes and consequences and the direction of transformation of agriculture is essential to take care of the agriculture-based economy. India, the largest populated country in the world, is responsible for producing food grains to feed a vast population. Hence. In the transformation process, there is a need to maintain a balance between food grain production and other commercial crops. To

frame the policy for this trade-off between food grain and commercial crop production needs watching the trend and nature of agricultural transformation. Further, proper land utilization policy is essential from an environmental perspective and land resource allocation among different activities. All this policy making would be made easy by analyzing the nature and trend of agricultural transformation.

SUGGESTIONS

- The consistent theme of labor scarcity, particularly in paddy cultivation, highlights the need for greater mechanization and technology adoption. Policymakers should focus on providing subsidies for farm machinery and introducing affordable small-scale mechanized tools that can reduce reliance on manual labor in marginal and small landholdings.
- Encouraging youth engagement in agriculture through skill-building programs in agro-technology may address labor gaps while modernizing farm practices.
- Considering the economic returns, the shift from traditional paddy cultivation to cash crops such as areca nut, coconut, and rubber also has implications related to food security. Policies should look at maintaining a balance between promoting cash crops and incentives to continue staple food crops cultivation.
- The expansion into horticulture and plantation crops has increased agricultural incomes, although more effective market links and cooperative farming arrangements now need to be developed to provide greater market access for farmers and reduce price variability.
- Results indicate an increase in the use of chemical fertilizers and, consequently, environmental degradation. Policies are needed that encourage organic modes of agriculture.
- Additionally, there should be development and integration into an integrated pest management system, coupled with soil health monitoring.
- Sustainable agricultural methodologies, including agroforestry, organic farming, and improved water management techniques, have the potential to alleviate environmental degradation while simultaneously preserving or increasing productivity. Thus, the structural transformation in agriculture seems to be influenced by the provision of policy support for infrastructure, market development, and extension services.
- The role of institutions like NITI Aayog needs to be developed for region-specific enhancement of agricultural initiatives, particularly for small and marginal farmers.

- Strengthening institutional frameworks for crop insurance, minimum support price, and better credit availability will be crucial in sustaining the transformation process of agriculture in Dakshina Kannada.
- The increase in the disparity in income between traditional farmers and cash crop farmers indicates that the government should, where possible, create safety nets for traditional farmers.
- Additionally, investments in allied industries like animal husbandry and fisheries could further provide avenues for supplementary incomes for farmers engaged in agriculture.
- An increased awareness through education and training among agricultural producers in rural areas is required for closing the knowledge gap and allowing smooth transitioning toward modern and sustainable farming practices.

  By integrating region-specific studies with ongoing evaluations of technological and policy impacts will provide a clearer picture of agricultural transformation. This comprehensive approach will support the development of sustainable practices and inform future strategies for balanced agricultural growth.

DIRECTION FOR FUTURE RESEARCH

This study aims to understand the nature of agricultural transformation within a small region of Coastal Karnataka, shedding light on the dynamic factors that drive such changes. Agricultural transformation, however, is a complex process that varies significantly across time and regions. To fully grasp the nature and contributing factors of these transformations, it is essential to conduct regular, region-specific research. Each region's unique environmental, economic, and social context influences how agriculture evolves, making periodic documentation a vital task.

Modernization plays a central role in driving these changes, but the nature of modernization and technology is continuously evolving. As such, ongoing research is required to measure the impact of new technologies, tools, and innovations on agricultural practices. Future studies should also consider the effects of government policies and market trends, which significantly shape agricultural transformation.

Moreover, a robust assessment of the economic implications of these shifts is needed to forecast the sustainability of agricultural practices and ensure that development remains balanced and inclusive. Understanding the economic viability of different

crops, technologies, and farming methods is key to promoting sustainable agricultural growth.

In this context, future research should focus on the following areas:

- Ongoing studies in different regions will help document how agricultural transformation varies and what factors are most influential in each area. Such documentation is necessary for formulating targeted agricultural policies.
- There is a need for continuous evaluation of the role modernization plays in driving agricultural transformation. This includes investigating the latest technologies, such as precision farming and automation, and their socioeconomic impact on farming communities, particularly small and marginal farmers.
- Understanding the influence of government interventions, market trends, and trade policies on agricultural transformation is critical. Future research should analyze how these external factors affect crop choices, farm income, and sustainability.
- A deeper exploration of the economic implications of agricultural transformations is necessary to ensure that these changes lead to sustainable development. Studies should focus on long-term economic forecasting, helping policymakers and farmers anticipate market demands and resource constraints.
- The broader social and environmental consequences of agricultural transformation must be explored further. This includes research on labor dynamics, the environmental sustainability of modern agricultural practices, and their overall impact on rural livelihoods.

Through continuous research in these areas, we can build a comprehensive understanding of agricultural transformation and its long-term implications, fostering a model of sustainable development that is both adaptable and resilient.

CONCLUSION

India’s traditional strength in agriculture has increased manifold on account of the efforts of our farmers and improvements in technology. We need to continue to improve and move from pure food security to a focus on a mix of agricultural production and the actual returns that farmers get from their produce.

As traditional farmers in most developing countries deploying traditional methods struggle to keep up with the efficiencies required by the market, farmers in developed countries suffering from a lack of workforce have increasingly taken to automated farming to solve the problems using robotics and advanced sensing.

The Agricultural production system results from a complex interaction of seed, soil, water, and agro-chemicals (including fertilizers). Therefore, judicious management of all the inputs is essential for the sustainability of such a complex system. The Green Revolution process transformed the country from a food deficit to a self-sufficient and food grain exporting country based on the increased use of high-yielding variety seeds, fertilizer, and irrigation. However, attention should have been paid to the inputs use efficiency (precision) and the ecological and environmental health, resulting in diminishing sustainability, profitability, and productivity growth.

In order to transform Green Revolution into an Evergreen Revolution and to enhance Productivity sustainably from the limited natural resources at the disposal, optimizing the resource input use efficiency assumes high priority, especially in the face of the decline in the total factor productivity, diminishing and degrading natural resources, stagnating farm incomes, lack of eco-regional approach, declining and fragmented land holdings, trade liberalization, limited employment opportunities in the non-farm sector, and global climate change. Against these odds, to feed a population of 1.7 billion by 2050, land productivity would need to be improved by four times, water productivity by three times, and labor productivity by six times. Moreover, these targets can be achieved only by generating and widely adopting innovative science-based policies and efficiency-enhancing precision technologies.

Agricultural research management and governance involve many decisions with scientific, social, and political consequences, posing unique challenges to the leadership. Every country has established agricultural research priorities based on many complex factors that must be considered when deciding on the research problems to be investigated. Resources must be shared among projects that compete for the limited funding that supports the total research enterprise. The wishes of stakeholders and the aspirations of the individual researcher must be considered. In addition, a system of incentives for the researcher (and his technicians) to promote first-class research within the institute's mandate will promote their output. Advancement based on merit and achievements is also necessary for government institutes to be free of regular civil service regulations. To prevent favoritism, these must be handled by independent promotion committees, including scientists from other institutions. Agricultural R&D policies and management must mainly be dictated and conducted by scientists familiar with the biotic, abiotic, and socio-economic constraints of crop production in developing countries. Historical and

political issues or lobbying from pressure groups should refrain from interfering with the mission of producing more and healthier food for the world's poor, rural, and urban sectors in a sustainable way.

These challenges, coupled with growing expectations from the stakeholders and society at significant and increasing competition (within the system as well as outside – regional and global), and relentless technology boom necessitate newer forms of leadership as well as organization and management (O&M) reforms to ensure that our NARES continues to remain relevant and effective in dealing with such dynamic ecosystem. ICAR, in its long journey so far, has seen many challenges and ably addressed them and met the expectations to a large extent by forward-looking and yet realistic measures the contemporary organizational leadership. However, it has to evolve a more dynamic human resource management strategy to effectively utilize the critical scientific mass for targeted outcomes, more specific to R4D.

With the growing challenges in the spheres of science & technology, fund & financing, policy & governance, and an ever-dynamic societal ecosystem, where the farming community is increasingly becoming aspirational – the professional competence matrix required for leading an organization of the size of ICAR is set to turn more complex.

Policymaking must focus on providing necessary support to this sector regarding skill and knowledge upgrades and access to financial capital and relevant technology.

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